RUPNARAYAN RIVER

Ecological status and trends

नमामि गंगे

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

ASSESSMENT OF THE ECOLOGICAL STATUS OF RUPNARAYAN RIVER FOR CONSERVATION PLANNING

This document is an output of the project Biodiversity Conservation and Ganga Rejuvenation sponsored by the National Mission for Clean Ganga, Ministry of Jal Shakti, Government of India, New Delhi.

Citation:

WII-GACMC (2022). Rupnarayan River: Ecological status and trends. Ganga Aqualife Conservation Monitoring Centre, Wildlife Institute of India, Dehra Dun, India. Pp. 28

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ACKNOWLEDGEMENTS

Ministry of Jal Shakti

Shri Gajendra Singh Shekhawat, Hon'ble Minister
Shri Pankaj Kumar, Secretary

National Mission for Clean Ganga (NMCG)

Shri G. Asok Kumar, Director General
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Preface

India being a megadiverse country, hosts a wide number of landscapes and ecosystems. A vital component of these are their riverine networks, which are in themselves a complete ecosystem. The nation's Ganga River is an internationally revered and recognised river that has been and continues to be a haven for a variety of animals and birds, making it an extremely important area with regard to biodiversity conservation. A number of tributaries make up the mighty Ganga River, of which the Rupnarayan River is also a part. They also provide essential provisioning and regulating ecosystem services. The Wildlife Institute of India through the Biodiversity Conservation and Ganga Rejuvenation Project and National Mission for Clean Ganga funded by the Ministry of Water Resources, River Development and Ganga Rejuvenation has been working towards the conservation of Rupnarayan River, along with all the other tributaries of Ganga River, so as to strengthen concerted efforts for restoration of its biodiversity value. For a complete scientific assessment of Rupnarayan River, robust information on the diversity, abundance and distribution of aquatic vertebrate fauna of Rupnarayan River, their major threats and the various drivers of these threats causing decline in their populations and habitat is collated in the present report.

As a part of the National Mission for Clean Ganga (NMCG), in the first phase, detailed biodiversity profiling of the Ganga River was carried out and subsequently the importance of its tributaries like the Rupnarayan River in supporting biodiversity was realized. With this in mind, in phase II the project "Planning and Management for Aquatic Species Conservation and Maintenance of Ecosystem Services in the Ganga River Basin for a Clean Ganga" was envisaged to prepare a holistic restoration plan for the Rupnarayan River through the support and involvement of stakeholders of all the Rupnarayan states. The Wildlife Institute of India through the Biodiversity Conservation and Ganga Rejuvenation Project and this report attempts to compile biodiversity of Rupnarayan River through literature review and Rapid Biodiversity Assessment. This report aims to develop a thorough knowledge base for the priority species of Rupnarayan River, aid in biological restoration, and assist policy planners and managers to judiciously use water from the Rupnarayan River, in view of the needs of the aquatic species therein.

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EXECUTIVE SUMMARY

The Rupnarayan River with its network of second order tributaries, including the Dwarakeswar, Silabati, Kangsabati and Damodar Rivers, is one of the major right bank tributary of the Hooghly River. The Rupnarayan River is the combined flow of two perennial rivers, Silabati River and Dwarakeshwar River. Rupnarayan River is characterised with high siltation and is influenced by tides. It joins the Hooghly River near Geonkhali. River basin of Rupnarayan River is characterised with rock types ranging from archean, proterozoic, metamorphic to sedimentary. The soil of the upper reaches are predominantly lateritic soil and clay laterites whereas the lower reaches have younger and newer alluvial soils. This basin has a typical tropical monsoon with an average rainfall of 1320 mm to 1630 mm. The drainage system of Rupnarayan River consists of several perennial and non-perennial rivers. From the downstream of Dwarakeswar and Silabati confluence, the Rupnarayan Rriver is influenced by semi diurnal tides and gradually becomes wider towards Hooghly River confluence. It flows through 3 western districts and 4 southern districts of West Bengal. The river basin falls in two biogeographic zones, viz., Deccan Peninsula and Gangetic Plain. The forest type of the basin is classified as 'Northern tropical dry deciduous' forest. Critically endangered northern river terrapin and gharial historically abundant in the Rupnarayan River basin are now locally extinct.

This survey was conducted during the month of December, 2020 to make a rapid assessment of biodiversity, to identify high biodiversity zones and threats to biodiversity. A vehicle cum boat biodiversity survey approach was adopted because of the unavailability of navigable water in throughout the river. A total of 54 Gangetic River dolphin were seen, these observations were restricted to the lower stretch only. Upper and middle stretch were not deemed suitable for dolphins to survive due to low depth and unavailability of water. Twenty-eight species of water and water-associated birds were recorded including 9 species of winter migrants. We also recorded the habitat parameters, water parameters and anthropogenic pressure. The anthropogenic stressors were very similar in the upper, middle and lower stretches of the river. Extensive unscientific fishing activity, riverbed agriculture, extraction of water from the river were the major anthropogenic activities observed.

1 INTRODUCTION

Rupnarayan-Dwarakeshwar basin lies in the south-western part of West Bengal (22°07´ N to 23°30´ N latitudes and 86°35´ E to 88°04´ E longitudes), that partially covers Puruliya, Bankura, Bardhaman, Purba and Paschhim Medinipur, Hooghly and Howrah districts of West Bengal (Santra, 2010). The length of Dwarakeshwar is 200.5 km (Sinha, 2016) and the length of Rupnarayan River is 79.5 km (Maity & Maiti, (2017), which together form a drainage area of 11349.64 km^2. The Rupnarayan River is one of the major right bank tributary of Bhagirathi River in West Bengal. Both tidal and fluvial activities are significant in this river and characterised with high siltation in the lower regime (Maity & Maity 2013; Biswas et al., 2015). The Rupnarayan River is the major water source for the West Bengal Power Development Corporation Limited (WBPDCL) thermal power plant at Kolaghat for power generation (Majumder et al., 2010).

1.1 Course of the River

The Rupnarayan River rises as Dhaleshwari (Dhalkisor) from the low lying Tilaboni hills in the Chota Nagpur plateau foothills, located northeast of Purulia city in the state of West Bengal. After its origin, the River follows a south-easterly course with little bifurcations through Bankura, Onda and Vishnupur blocks and leaves Bankura district near Huzra in Kotulpur block. Past the city of Bankura, the river is popularly known as Dwarakeshwar River and enters Hooghly district at Goghat and joins the Shilabati (Silai) River near Bandar in Paschim Medinipur district (Santra et al., 2016). The combined flow of Dwarakeshwar and Shilabati Rivers is named as Rupnarayan River and it flows in an eastward direction. The river then joins the Hugli (Hooghly) at Geonkhali, covering a distance of 240 km (Majumder et al., 2010). The Rupnarayan River network drains throughout the state of West Bengal and is bordered by Hooghly district in the East, Purulia and Bankura in the West, and Purba and Paschim Medinipur districts in the South and Bardhaman district in the North. As a part of Hooghly estuary, the stretch of the Rupnarayan River between Ghatal and Geonkhali is influenced by the semi-diurnal tide and the continuous of sedimentation process at lower reach is the sole outcomes of the interaction of riverine and marine processes (Maity & Maity, 2015).

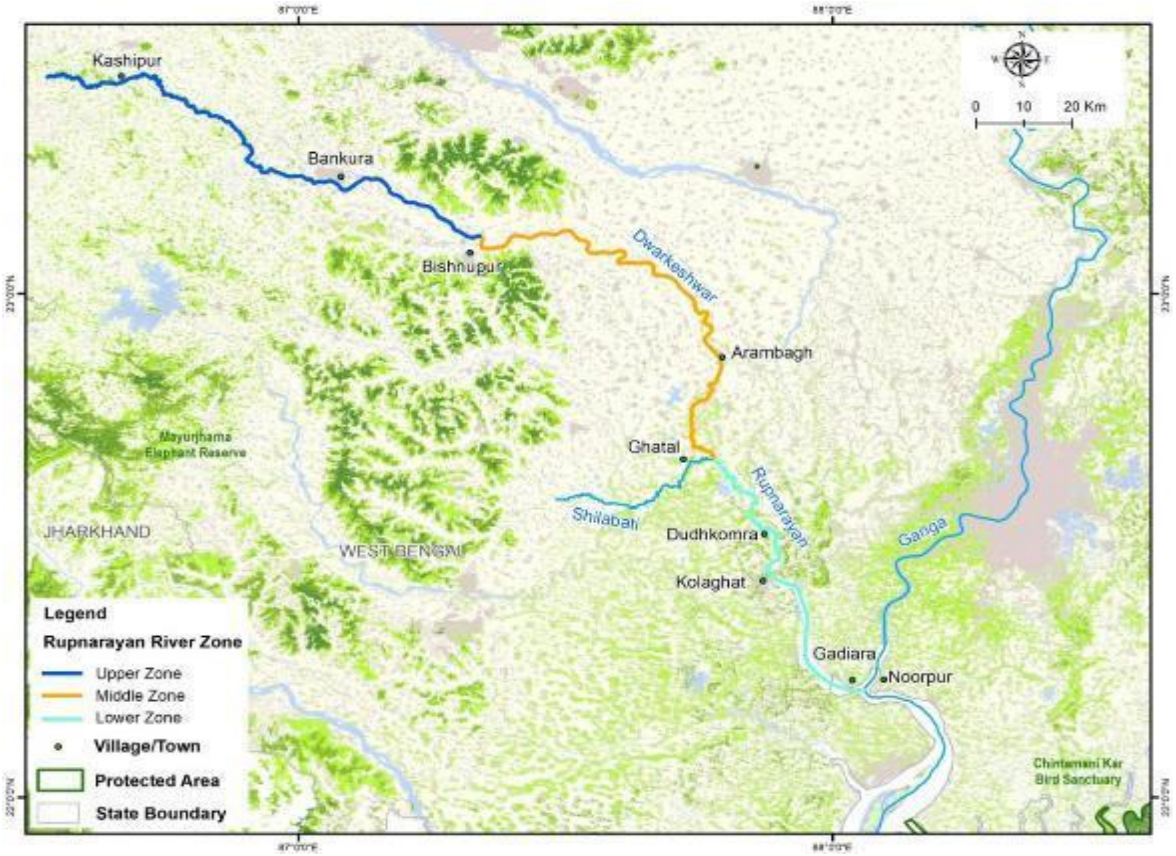


Figure 1 Zonation map of the Rupnarayan River

The river can be categorized into three zones on the basis of terrain characteristics, river geomorphology and biogeographical provinces (Figure 1), viz. the upper zone (Madhabpur-Bishnupur), the middle segment (Bishnupur-Shilabati confluence) and the lower segment (Shilabati-Hooghly confluence) (Table 1).

1.2 Geology and Geomorphology

The Rupnarayan River basin is composed of various kinds of rocks ranging from Achaean Proterozoic Metamorphic to the sedimentaries of recent age (Santra et al., 2016). Geo-morphologically the river basin drains between the fringe of the tectonic shelf of the Gondwana and the western extension of Bengal delta (Singh et al., 1998). The slope of the river basin is generally from North-west to South-east direction (Santra, 2010). The upper reach of the River network is composed of dissected hill slopes, highly gullied land and pediplains, steep valley like profiles between hillocks and mounds of low altitude that resemble virtually an extension of the Chhota Nagpur plateau (Nandy & Pal, 2014). This undulating landform with an average elevation of 150 m covers approximately 30% area of the Rupnarayan River basin (Santra et al., 2016). The lower portion is composed of upper alluvial plain and lower alluvial plain along with deltaic flood plain and coastal plain (Maity & Maiti, 2016). The alluvial plain contributes to almost 70% area of the entire basin with an average elevation of 30 m. The Rupnarayan River is relatively narrow in the upper reach (maximum width is 280 m) but it gradually expands on its downward journey (reaching a maximum width of 4250 m). The Rupnarayan River between Bandar to Geonkhali is influenced by the semi-diurnal tide and sedimentation at lower reach is the result of the interaction of riverine and marine processes. In the dry months, huge volume of brackish water can penetrate easily up to Kolaghat during high tide, but in rainy months the salt water is driven out by the volume of freshwater brought down from upper catchment (Maity & Maiti, 2016).

1.3 Soil Types

The coarse lateritic soil and clay laterites predominate in the western and north-western region of the middle and upper catchment of the River. Younger and newer alluvial soils are found mostly in the south and south-east region of the catchment area, which are enriched by silt and clay deposition. Due to the limited coverage of sandy loam soil in the eastern and south-eastern part of the region, the rate of percolation is very limited. The lower water percolation capacity of soil in the upper catchment increases surface runoff and storage of water at the lower catchment of the river. This is an important cause of accelerated rate of soil erosion and rapid sedimentation on the river bed (Maity & Maiti, 2016).

1.4 Climate

The climatic condition of the Rupnarayan River basin varies from moist tropical in the southeast to dry tropical in the southwest (Santra et al., 2016). The main seasons are summer, rainy season, a short autumn, and winter. While the summer in the delta region is noted for excessive humidity, the western highlands experience a dry summer with the highest day temperature ranging from 38°C to 45°C that rises sharply from March to May, minimum temperatures of 5-6°C are recorded during winters (November to February) (Majumder et al., 2010; Nandy & Pal, 2014). At nights, a cool southerly breeze carries moisture from the Bay of Bengal. Broadly, the Rupnarayan River basin has a typical tropical monsoonal type of climate with an average rainfall of 1320 mm to 1630 mm and annual temperature ranging from 11 °C to 45 °C (Maity & Maiti, 2013).

1.5 Drainage and Hydrology

The drainage system of the Rupnarayan-Dwarakeshwar River basin consists of several perennial and non-perennial rivers. The rivers that drain off into the basin are Rupnarayan, Dwarakeswar and Silai/ Shilabati along with the Gandheswari. The Gandheswari, a non-perennial river is prone to flashfloods during monsoon. The Shilabati River commonly known much as Silai, meets two of its small tributaries viz. Jaypanda and Purandar near Bankura and flows in a south-western direction and finally enters Paschim Medinipur district. Passing through Garhbeta, Kharhkusma, Narajol, in Paschim Medinipur district the Silai joins Dwarkeswar River to form Rupnarayan River (Nandy & Pal, 2014). The Gandheshwari River originates from the south-west of the Sunsunia hill, north of Bankura district. It is characterised with rocky beds, and joins the Dwarakeshwar River near Bhutsahar at Bankura town (Neogi, 2011). The upper reach of the Rupnarayan River, upstream of the Shilabati and Dwarakeshwar confluence, is a non-tidal river. The Rupnarayan River from downstream of Bandar is a tidal river that flows in a south-east direction. The upper reach of the Rupnarayan River is mainly narrow (<250 m) whereas the lower reach of the river between Kolaghat and Geokhali turns out to be wide (>2000 m), with

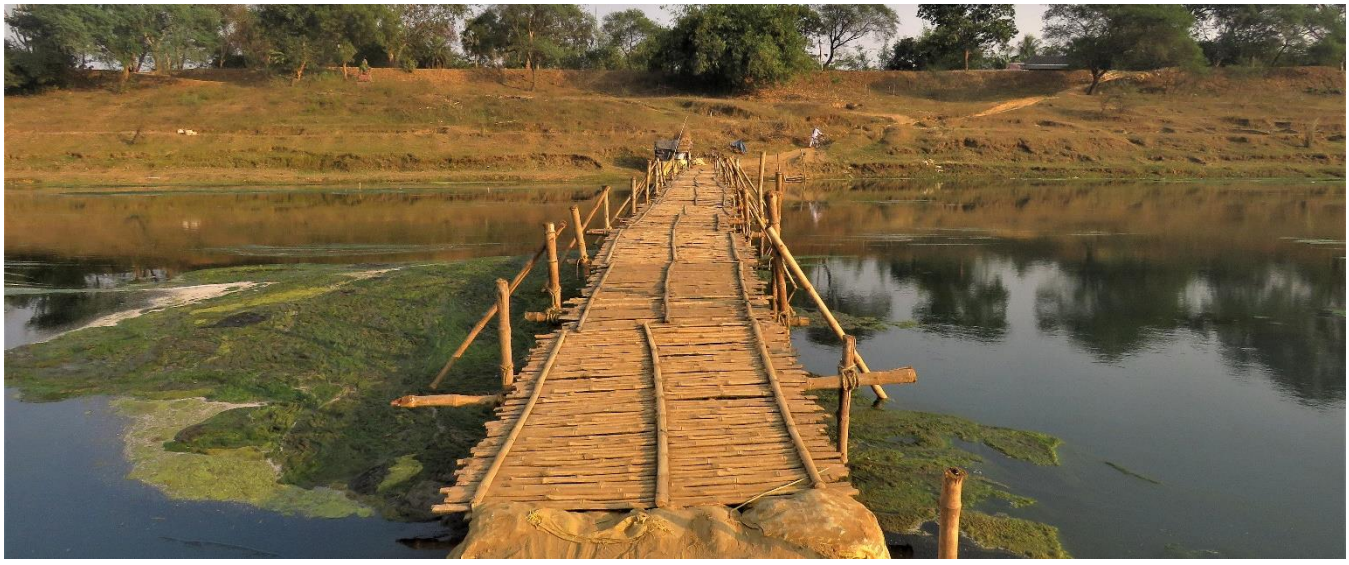
intertidal mud flats and grassy chars (exposed grassy islands formed due to accretion of sediments) (Santra et al., 2016; Maity & Maity, 2017).

1.6 Biogeography, Flora & Fauna

The Rupnarayan River flows through two biogeographic zones, viz., Lower Gangetic Plain- 7B and the Deccan Peninsula (Chhota Nagpur Plateau- 6B) (Rodgers & Panwar, 1988). The basin has experienced heavy deforestation in recent past due to escalating anthropogenic influences (Nandy & Pal, 2014). The vegetation of the basin represents 'Northern tropical dry deciduous' forest type (Champion & Seth, 1968). The forests are a source of timber, fuelwood and charcoal, lac and Sal leaves are important non-timber forest products. Among the key aquatic species the Northern river terrapin (*Batagur baska*) and gharial (*Gavialis gangeticus*) reported to be historically abundant in the Rupnarayan River basin, are now locally extinct (Dassarma et al., 1982) (Table 1 & Figure 2).

Table 1 Bio-geographical provinces, floral and faunal assemblages of the Rupnarayan River basin

River segment	Bio-geographic Province	Length (km)	Characteristics	Forest cover (km^2)	Species Richness						No. of Protected Areas
					Mammals	Bird	Turtle	Gharial	Mugger	Fish	
Upper (Madhabpur-Bishnupur)	Chhota Nagpur Plateau (6B)	112	Undulating landform with an average elevation of 150 m	2201.46	NA	NA	NA	NA	NA	NA	Mayurjharna Elephant Reserve
Middle (Bishnupur-Shilabati confluence)	Chhota Nagpur Plateau (6B) and Lower Gangetic Plain (7B)	103	Narrow channel with pebbles and sand	3910.89	NA	NA	NA	NA	NA	NA	Nil
Lower (Shilabati - Hooghly confluence)	Lower Gangetic Plain (7B)	71	Gangetic plain with Tidal zone	3285.36	1	12	NA	NA	NA	46	Nil



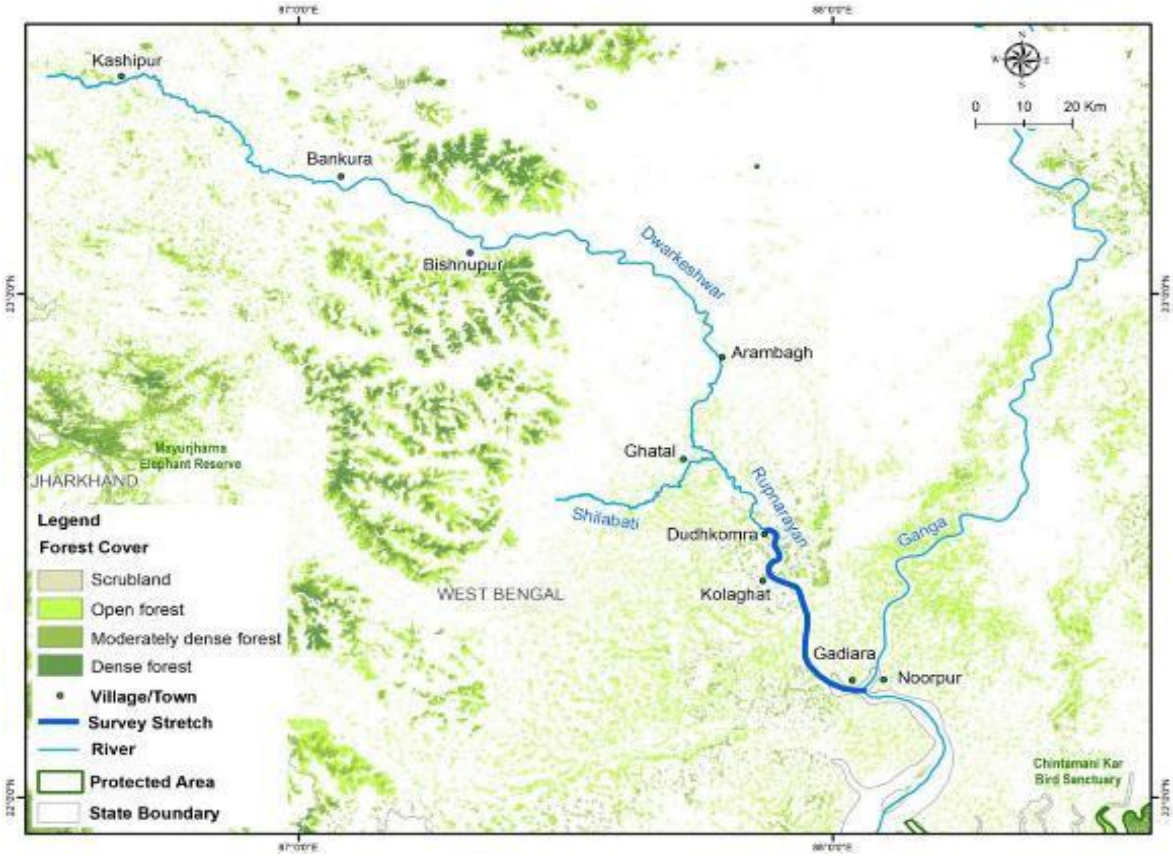


Figure 2 Forest cover map of the Rupnarayan River basin

1.7 Demography

The Rupnarayan River basin supports an average human population density of 1265.85 individuals/ km^2. Population density in the upper zone is lesser than that of middle and lower zones (GOI, 2011; FSI, 2019) (Table 2 & Figure 3). The Rupnarayan River basin is primarily inhabited by rural population. The rural economy largely depends on agriculture. Nearly 50% of the working people in the basin are directly connected with agriculture. Of these, nearly 27% represent large, medium, or small farmer communities while the rest work as agricultural farm labourers. During last decade the agricultural sector in the West Bengal has intensified and of the 8,684,000 hectares of total area, nearly 67% areas is cultivated (Majumder et al., 2010).

Table 2 Human density along Rupnarayan River (Source: GOI, 2011; FSI, 2019)

Zone	Districts	Geographical Area	Persons	Density (Persons/km^2)
Upper	Puruliya	6259	2930115	468
	Bankura	6882	3596674	523
Middle	Bankura	6882	3596674	523
	Bardhaman	7024	7717563	1099
	Hooghly	3149	5519145	1753
	Howrah	1467	4850029	3306
	Paschim Medinipur	9368	5913457	631
Lower	Howrah	1467	4850029	3306
	Paschim Medinipur	9368	5913457	631
	Purba Medinipur	4713	5095875	1081
TOTAL		**56579**	**49983018**	**1265.85**

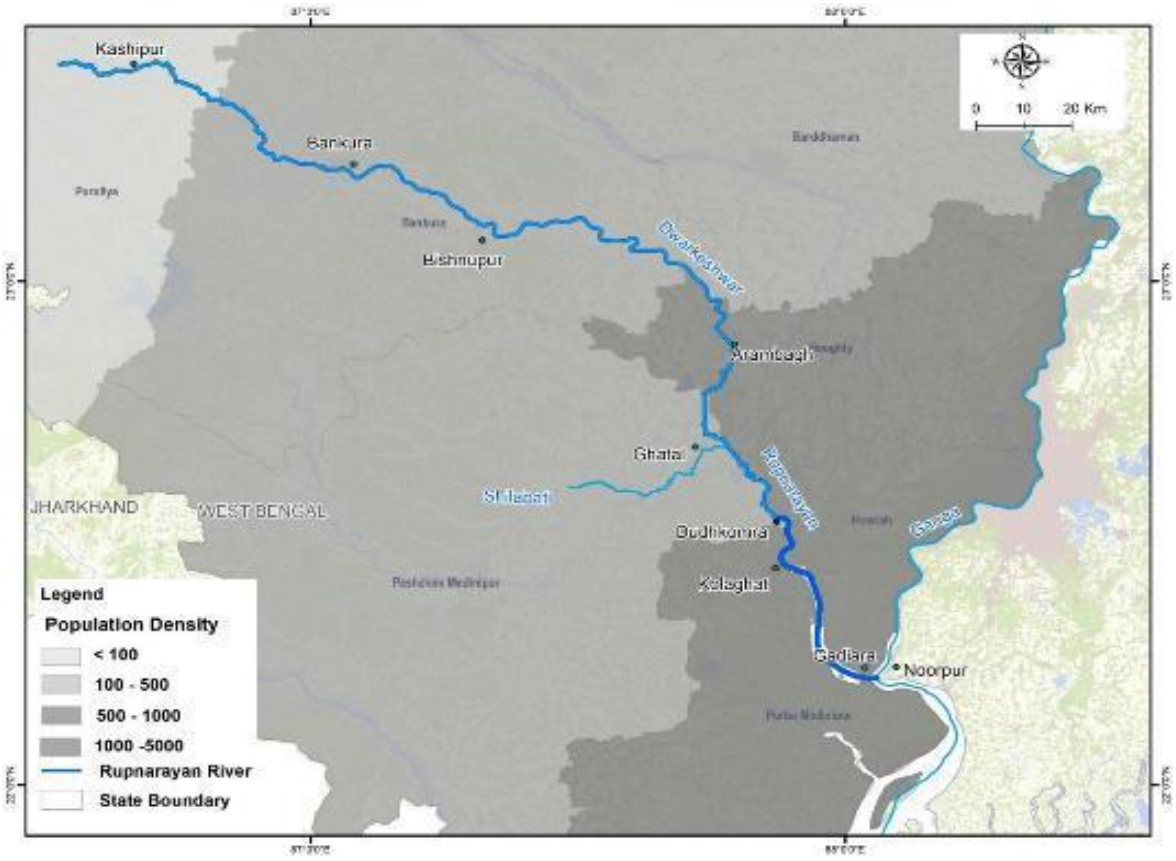


Figure 3 Density map of the Rupnarayan River basin

1.8 Land Use Land Cover

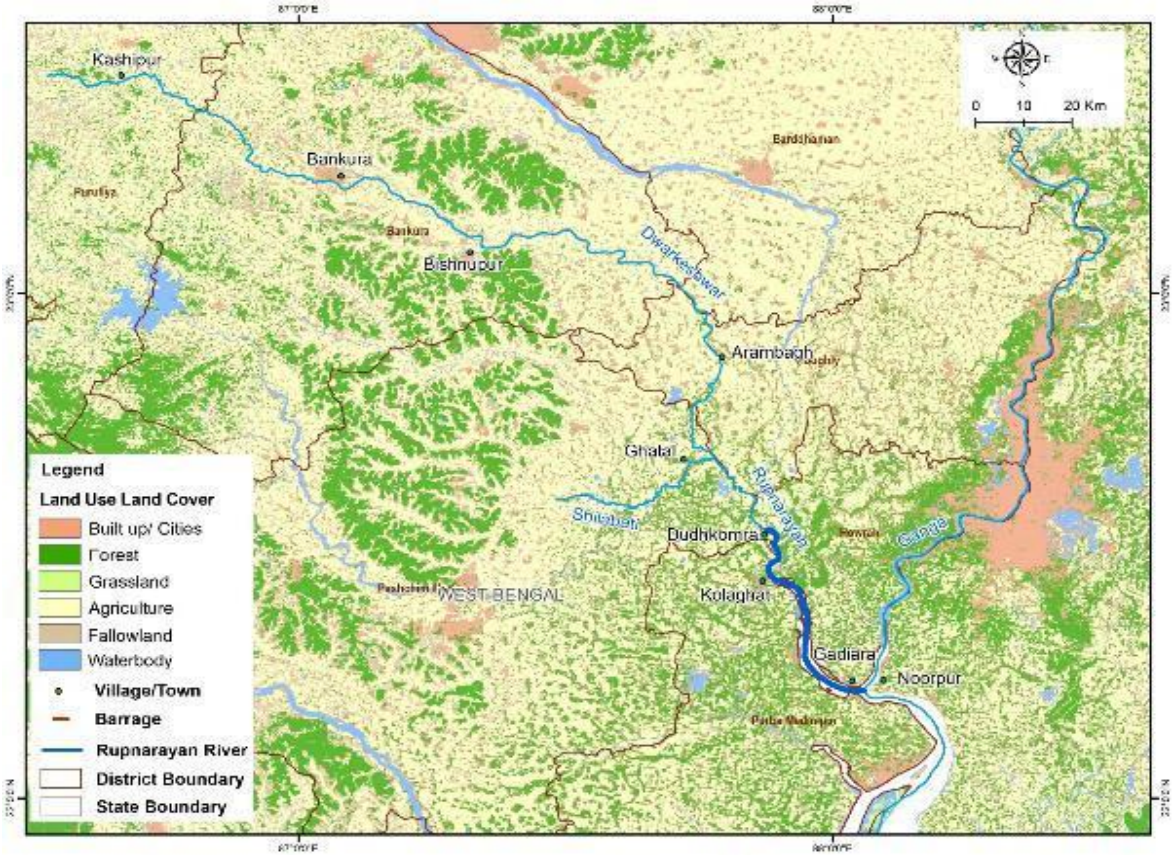


Figure 4 Land use Land cover map of the Rupnarayan River basin in West Bengal basin

Table 3 District wise Land Use Land Cover change of Rupnarayan River basin (2005-2016 & 2015-2016)

District	Built up (%)		Forest (%)		Grassland (%)		Agriculture (%)		Fallowland (%)		Waterbodies (%)	
	2005-2006	2015-2016	2005-2006	2015-2016	2005-2006	2015-2016	2005-2006	2015-2016	2005-2006	2015-2016	2005-2006	2015-2016
BANKURA	7.66	9.34	21.03	21.12	0.00	0.00	50.23	57.69	16.37	7.25	4.70	4.60
BARDDHAMAN	11.89	14.60	7.27	7.26	0.00	0.00	68.05	70.39	9.42	4.82	3.38	2.93
HOOGHLY	13.27	18.06	12.81	12.88	0.01	0.01	62.89	63.21	7.32	2.72	3.69	3.11
HOWRAH	13.96	17.67	37.34	37.32	0.01	0.01	37.56	36.15	6.45	3.74	4.69	5.11
PASHCHIM MEDINIPUR	6.28	9.89	27.55	27.57	0.00	0.00	49.91	52.68	14.11	7.76	2.16	2.10
PURBA MEDINIPUR	5.65	10.31	31.87	31.86	0.26	0.28	46.63	44.87	11.80	8.35	3.80	4.34
PURULIYA	4.96	5.36	15.55	15.56	0.02	0.02	40.06	63.28	35.30	11.75	4.12	4.02

2. STATUS OF AQUATIC WILDLIFE IN RUPNARAYAN RIVER

Presence of Gangetic dolphin in the Rupnarayan River was reported for the first time by WWF-Nepal in the year 2006, in a 42 Km stretch between Gadiara and Mankur. Thereafter Mitra et al (2015), Chowdhury et al (2016) and recently WII (2018) reported dolphin presence in various locations of the Rupnarayan River. Nandy & Pal (2014), Mitra et al (2013) and Chini et al (2018) reported a total of 46 fish species from sporadic locations of the Rupnarayan River (Annexure II). The only study on the vegetation from the Rupnarayan basin was by Pradhan et al (2005), who reported 20 species of plants.

Table 4 Status of aquatic biodiversity in the Rupnarayan River

Mammal (Gangetic Dolphin)	Bird	Reptile	Amphibian	Fish	Vegetation	Reference
+	+	+		+		WII (1994)
				25		Mishra (2003)
					20	Pradhan et al (2005)
+				26		Mitra et al (2015)
+						Chowdhury et al (2016)
				3		Chini et al (2018)
+						WWF-Nepal (2006)
+						WII (2018)

(+ indicates the species being reported as present in the river)

Since information on the aquatic diversity form Rupnarayan River is scanty, the survey was carried out to obtain a preliminary information of riverine habitats, species occurrence and distribution and threats to the key aquatic species of the Rupnarayan River.

2.1 Methodological Framework

The biodiversity survey framework and species-specific assessment methods were developed after an extensive literature review on the distribution and occurrence of aquatic life forms, habitat profile and location of major settlements along the Rupnarayan River. The rapid biodiversity assessment was carried out during December, 2020 from Durgasingdi village (N 23° 25’ 57.57”, E 86 ° 32 ’ 11.02) (origin of Dwarakeshwar River), Puruliya district to Gadiara (N 22° 12’ 48”, E 88 ° 02 ’ 48) (confluence of Rupnarayan and Hooghly river) covering a length of 280 km. A combination of vehicle cum boat based visual encounter surveys were conducted depending upon geomorphology and channel attributes of the Rupnarayan River. Vehicle survey was conducted in the upper and middle zone of the river between Puruliya and Bandar for 200 km across 28 sampling sites. Boat based visual encounter survey was performed using a double engine country boat from downstream of Bandar to the confluence of Hooghly River during high tide covering a stretch of 80 km. Species-specific assessment protocols followed are detailed below:

Gangetic dolphin

A vessel based visual count method (Perrin & Brownell 1989; Sinha, 1997; Smith & Reeves 2000; Smith et al. 2006; Behera et al. 2013) was adopted to enumerate the sighting occurrence of dolphins (*Platanista gangetica*) in the Rupnarayan River. Sighting of dolphins was recorded between 8:00 hrs to 12:00 hrs in the morning and 16:00 hrs to 18:00 hrs in the afternoon using a country boat moving at a speed of 8–10 km per hour. Three independent observers were stationed at the motor boat in three different directions (right, left and front) to obtain concurrent records of dolphin sightings.

Reptiles

Direct observation method was employed to assess the relative abundance and occurrence of gharial, mugger and turtles (Singh, 1985; Hussain, 2009). Two observers recorded total numbers of individual of gharial, mugger, and turtle and associated habitat parameters. The surveys were made during the peak basking time and it was assumed that all individuals come out from water for basking.

Avifauna

Abundance of waterbirds was obtained using Total Count Method (Sutherland et al. 2004; Sutherland 2006). Field recordings of waterbirds were done with naked eye and using 50×10 Nikon binoculars follow by comparison with field guide (Grimmett et al. 2016; Gopi & Hussain, 2014).

Habitat Parameters

During the pilot survey, indices for habitat quality were noted down at each 5 km interval. The parameters such as water current (slow, medium, fast), channel depth and channel width (m), bank characteristics (right & left), shoreline vegetation (right & left), GPS coordinates, confluences, meanders, sandbars, physicochemical parameters as well as anthropogenic factors were recorded. Channel depth (m) and Channel width (m) were recorded with a GARMIN Striker Plus fish finder and a YUKON laser range finder, respectively. YSI Pro DSS multi parameter water quality meter was used to measure physico-chemical parameters such as dissolved oxygen, pH, conductivity, salinity, TDS, water temperature. These parameters were monitored through in situ measurement techniques following standard procedures of APHA (1998). Bank characteristics were broadly classified into five categories viz., 1. Pebbles and boulders; 2. Sandy; 3. Loamy; 4. Clayey and 5. Rocky embankment based on geomorphic features and substrate types of the river. Shoreline vegetation was grouped into three major classes i.e., fully covered (> 90% bank surface covered with riparian vegetation); partially covered (< 50% green cover) and exposed (< 10% green cover). As a measure of indices of the quality of river bank a series of river bank scenarios were assessed, based on bank slopes ranging from vertical (90° from horizontal) to an angle of < 30° from horizontal. Slopes of the bank were then classified into three categories viz. low slope (< 30°), medium slope (30-60°) and high slope (> 60°) (Doble et al., 2012).

2.2 Gangetic dolphin

A total of 54 visual detection of surfacing dolphin were recorded in 29 sighting occasion. Dolphins were encountered between the confluence of Shilabati and Dwarekeswar River to Gadiara (confluence of Rupnarayan and Hooghly River (Figure 5). The encounter rate was 0.72 ± 2.87 sightings km^{1}. Encounter percentage of sub-adults (62.96%) were highest amongst the recorded data followed by adults (29.62%), neonates (3.7%) and unclassified (3.7%). Dolphins were encountered in river depths between 1.4 to 5.3 m, with an average river depth of 3.22 ± 1.15 m. Dolphin sightings were recorded in river stretches with width ranging from 105 m and 3100 m, and an average river width of 913.62 ± 1001.37 m (Table 6).

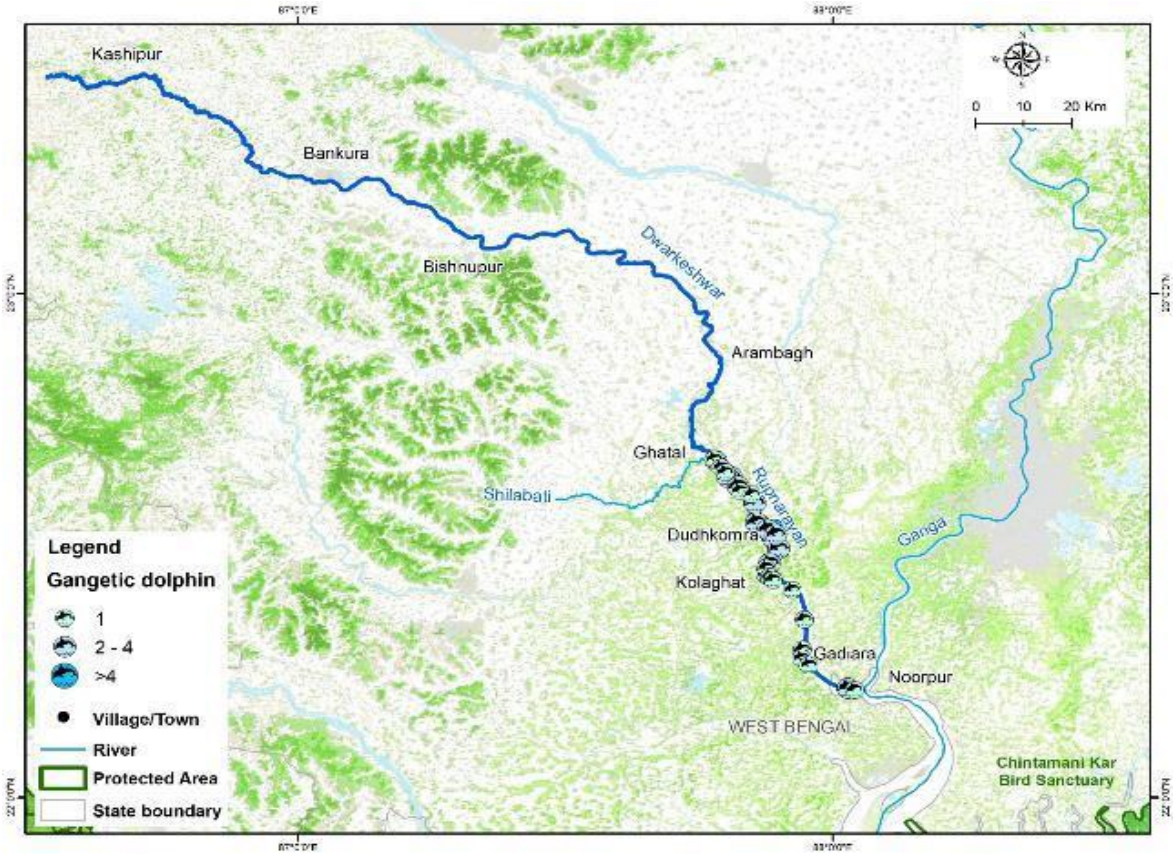


Figure 5 Map of Gangetic dolphin recorded during post monsoon survey in Rupnarayan River

Table 6 Sighting occurrences of Gangetic dolphin (*Platanista gangetica*) in the Rupnarayan River observed during the post-monsoon biodiversity survey.

Stretch	Sighting occurrence	Dolphin sightings	Adult	Sub-Adult	Neonates	Unclassified	River depth (m)	River width (m)
Silabati-Dwarakeshwar river confluence to Gadiara	1	1	0	1	0	0	5	125
	2	3	1	2	0	0	4.3	130
	3	1	0	1	0	0	3.1	105
	4	1	0	1	0	0	4.3	140
	5	2	0	2	0	0	4.8	120
	6	4	1	2	0	1	4.7	130
	7	2	1	1	0	0	5.3	170
	8	1	0	1	0	0	2.3	190
	9	1	0	1	0	0	3.9	205
	10	2	1	1	0	0	2.3	230
	11	2	1	0	0	1	2.1	280
	12	3	1	2	0	0	3.7	310
	13	2	0	2	0	0	2.6	280
	14	5	2	3	0	0	3.5	310
	15	2	0	2	0	0	2.6	400
	16	3	1	2	0	0	3.1	560
	17	3	2	0	1	0	5.3	620
	18	2	1	0	1	0	4.6	740

	19	1	0	1	0	0	1.9	790
	20	3	1	2	0	0	2.1	830
	21	1	0	1	0	0	1.4	950
	22	1	0	1	0	0	1.9	1040
	23	1	0	1	0	0	1.4	1700
	24	1	0	1	0	0	2.7	2190
	25	1	0	1	0	0	2.8	2390
	26	1	0	1	0	0	2.3	2570
	27	1	1	0	0	0	2.9	2850
	28	2	1	1	0	0	2.6	3100
	29	1	1	0	0	0	4	3040

Table 7 Encounter rate of Gangetic dolphin (*Platanista gangetica*) in the Rupnarayan River observed during the post-monsoon biodiversity survey

Stretch	Segment (5km)	Sighting occurrence	No. of sightings	ER (Sightings/Km)	Channel depth ± SD	Channel width ± SD
Silabati-Dwarakeshwar river confluence to Gadiara	1	4	6	1.2	4.42 ± 0.72	124.17 ± 11.58
	2	2	6	1.2	4.90 ± 0.27	135 ± 23.80
	3	3	4	0.8	3.78 ± 1.55	191 ± 21.91
	4	1	2	0.4	2.33 ± 0.25	243.33 ± 32.15
	5	3	7	1.4	2.75 ± 0.68	287.5 ± 15
	6	3	10	2	3.42 ± 1.12	434 ± 150.6
	7	1	3	0.6	4.33 ± 1.67	730.67 ± 191.68
	8	3	6	1.2	2.58 ± 1.15	870.4 ± 123.01
	9	3	3	0.6	1.65 ± 0.29	1182.5 ± 347.6
	10	0	0	0	2.05 ± 0.49	1800 ± 141.42
	11	1	1	0.2	2.57 ± 0.15	2106.67 ± 180.09
	12	0	0	0	2.90 ± 0.42	2365 ± 190.92
	13	2	2	0.4	2.83 ± 0.39	2615 ± 267.15
	14	1	1	0.2	3 ± 0.15	2850 ± 150
	15	2	3	0.6	3.27 ± 0.7	2946.67 ± 215.72

Of the total dolphin sightings 59% of sightings were occurred between the river depth of 2m to 4 m followed by 33% of sightings recorded above the river depth of 4 m and 7% sightings were below 2 m of water depth (Figure 6).

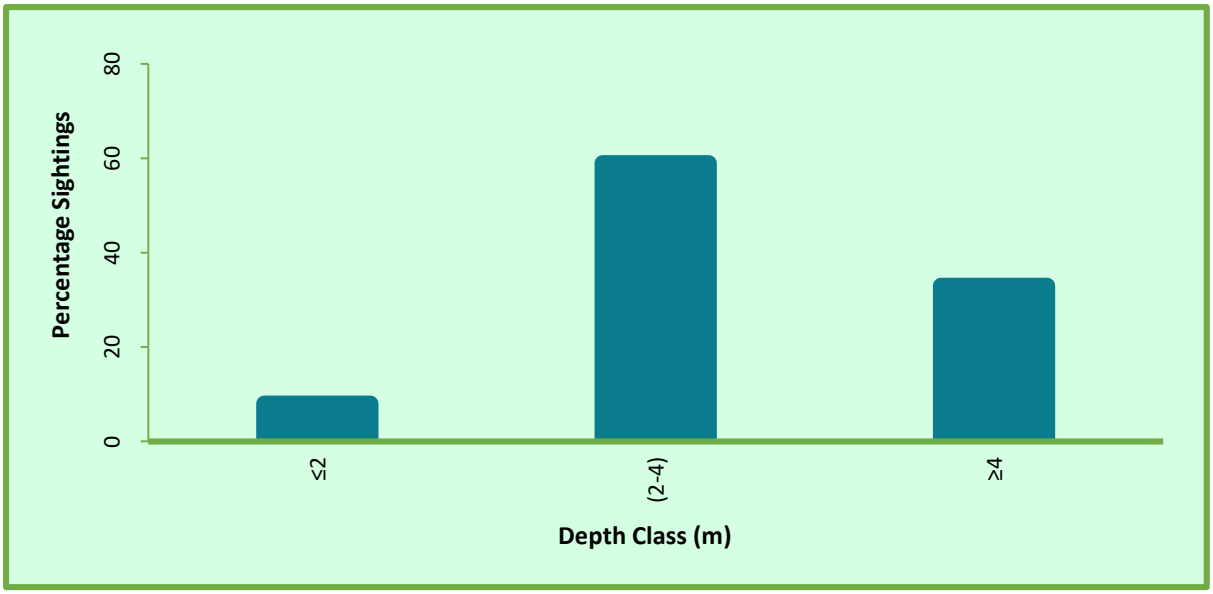


Figure 6 Distribution of Gangetic dolphin in different depth classes of the Rupnarayan River observed during the post-monsoon biodiversity survey.

2.3 Avifauna

A total of 28 species of water and water-associated birds, belonging to 12 families and 5 orders were recorded during the survey (Figure 7). Six species were of Ardeidae family, 4 species of Scolopacidae, followed by three species each in Alcedinidae, Charadriidae and Motacillidae family. Anatidae and Jacanidae accounted for two species each. Families Ciconiidae, Pandionidae, Phalacrocoracidae, Podicipedidae and Rallidae had one species each (Figure 8).

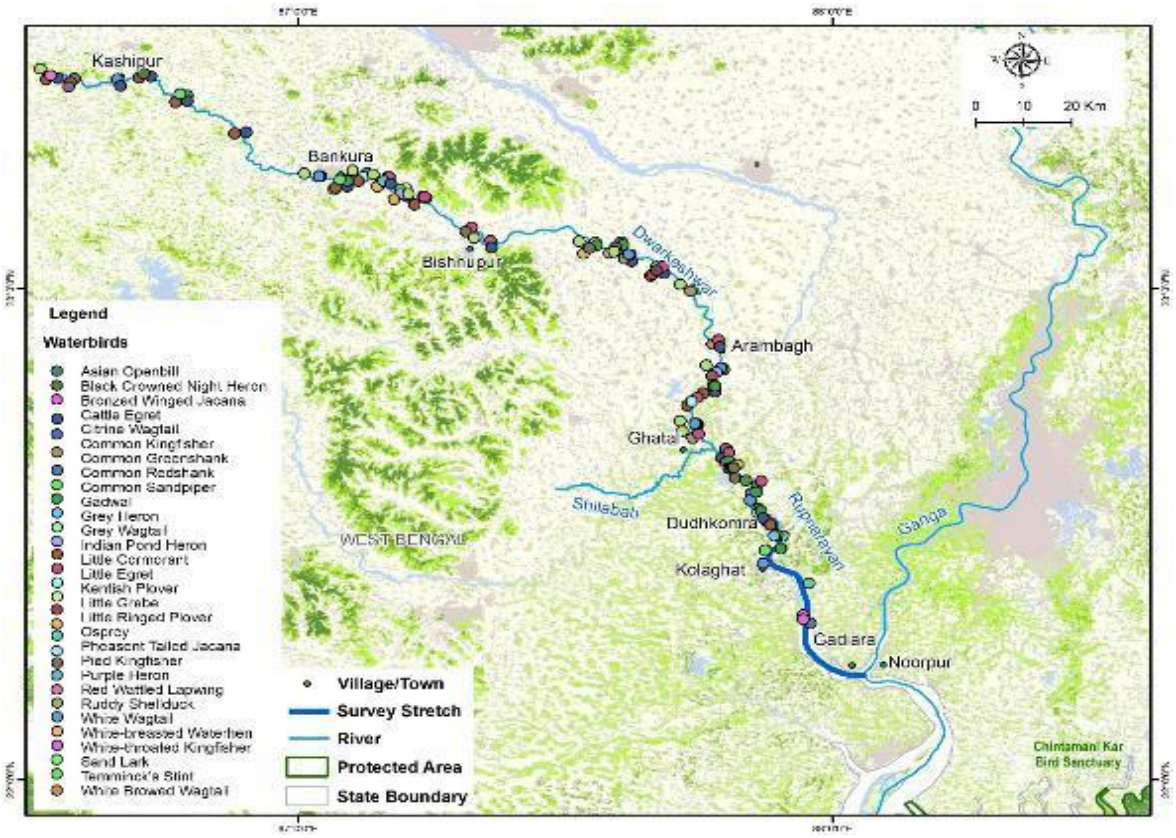


Figure 7 Map of waterbird species recorded during post monsoon survey in Rupnarayan River

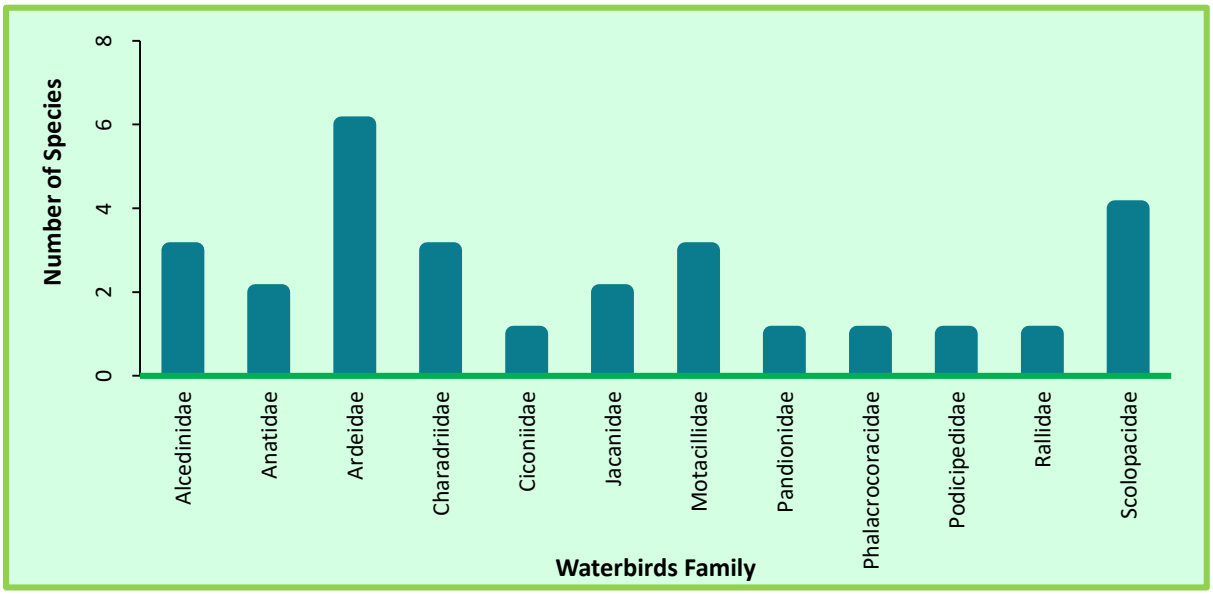


Figure 8 Family wise composition of waterbirds communities across the Rupnarayan River observed during the post-monsoon biodiversity survey.

Fourteen species were resident, 5 species were winter migrant, 5 species were residents with local migrantion , 2 species were resident and winter migrant and 1 species each in resident with summer and winter movements and resident local as well as summer movements (Figure 9). According to their feeding habits 9 feeding guilds were represented, 8 species belonged to carnivorous group, 6 species in piscivorous/insectivorous. Insectivorous group accounted 4 species followed by piscivorous/carnivorous (3 species), 2 species each in omnivorous and herbivorous/insectivorous. Each of the group herbivorous, piscivorous and carnivorous/insectivorous had one species each (Figure 10).

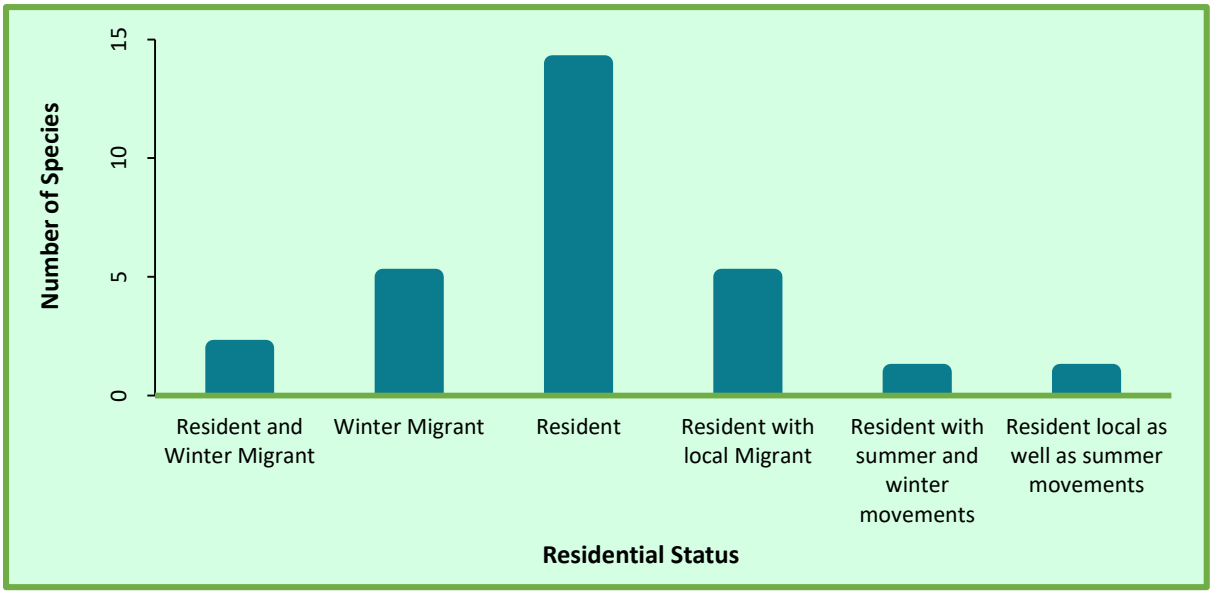


Figure 9 Residential Status of Waterbirds communities across the Rupnarayan River observed during the post-monsoon biodiversity survey.

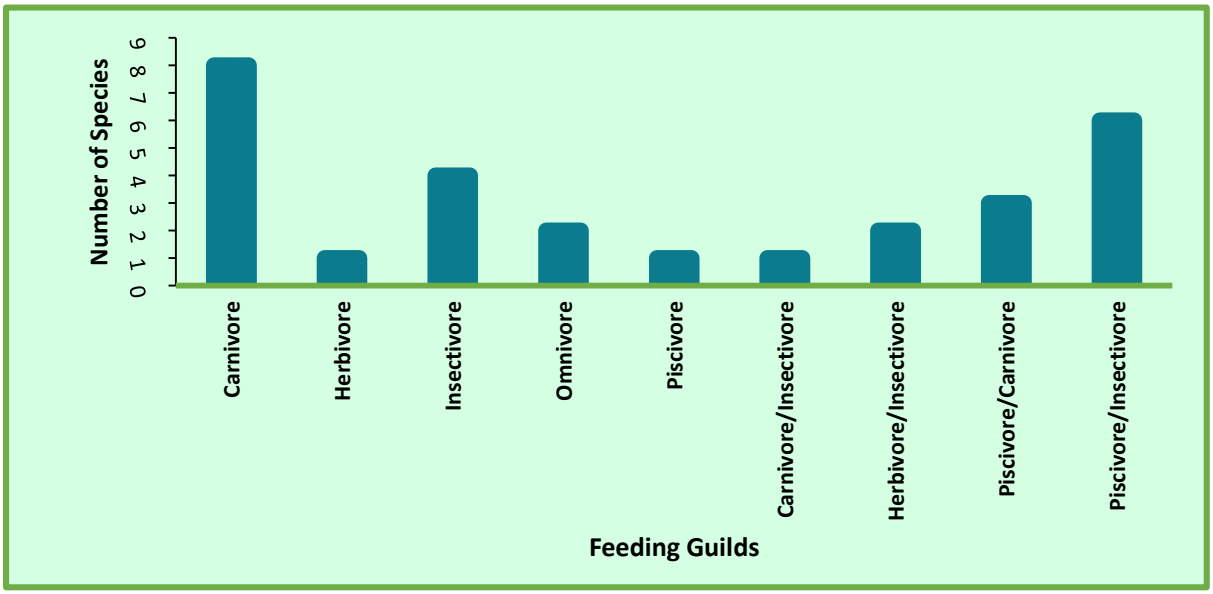


Figure 10 Feeding guilds composition of Waterbirds communities across the Rupnarayan River observed during the post-monsoon biodiversity survey.

2.4 Habitat Parameters

The depth and width of the Dwarakeshwar-Rupnarayan river stretch shows a very large variation from origin to confluence. The channel depth ranged from 0.2m to 5.3m (Average = 1.74 ± 1.47) (Figure 11) and the channel width ranged from 10m to 3000m (Average = 400.31 ± 764.11) (Figure 12). River width and depth gradually increased from the confluence of Silabati River near Ghatal and width was maximum at the confluence of Hooghly River.

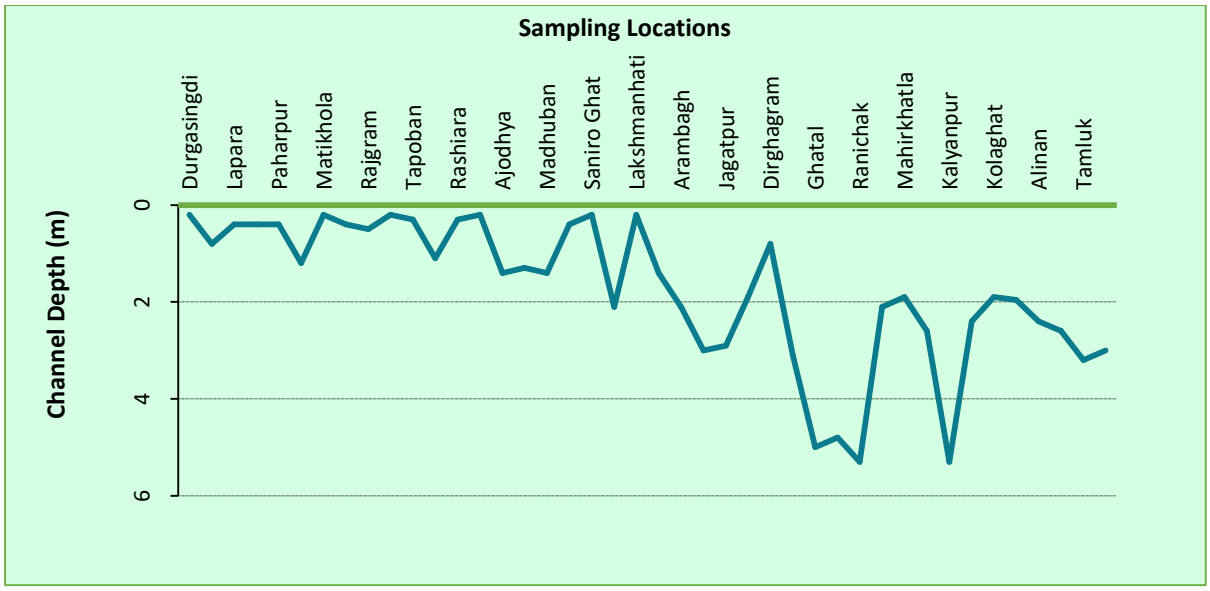


Figure 11 Channel depth profile of the Rupnarayan River sampled during post monsoon season, 2020

The substrate of the right bank of the sampled stretch of the Rupnarayan River was mostly loamy (50%), followed by rocky with pebbles (31.67%), clayey (10%) and sandy (8.33%) Loamy substrate (50%) was dominant on the left bank as well followed by rocky with pebbles (26.67%), sandy (16.67%) and clayey (6.66%).

The left bank profile of the sampled river segment was found to be shared by partial vegetation cover (90.47%), fully vegetated (7.14%) and exposed (2.39%) categories respectively. The right bank of the sampled river segments had 83.33% area under partial vegetation cover followed by fully vegetated (11.90%) and 4.77% area under exposed category.

About 61.90% of the sampled river segments on the left bank had medium slope, followed by low slope (23.80%), high slope accounted for 16.67% of the river stretch, whereas on the right bank 52.38% of the sampled river segments had medium slope followed by high slope (30.95%), 16.67% was under low slope category.

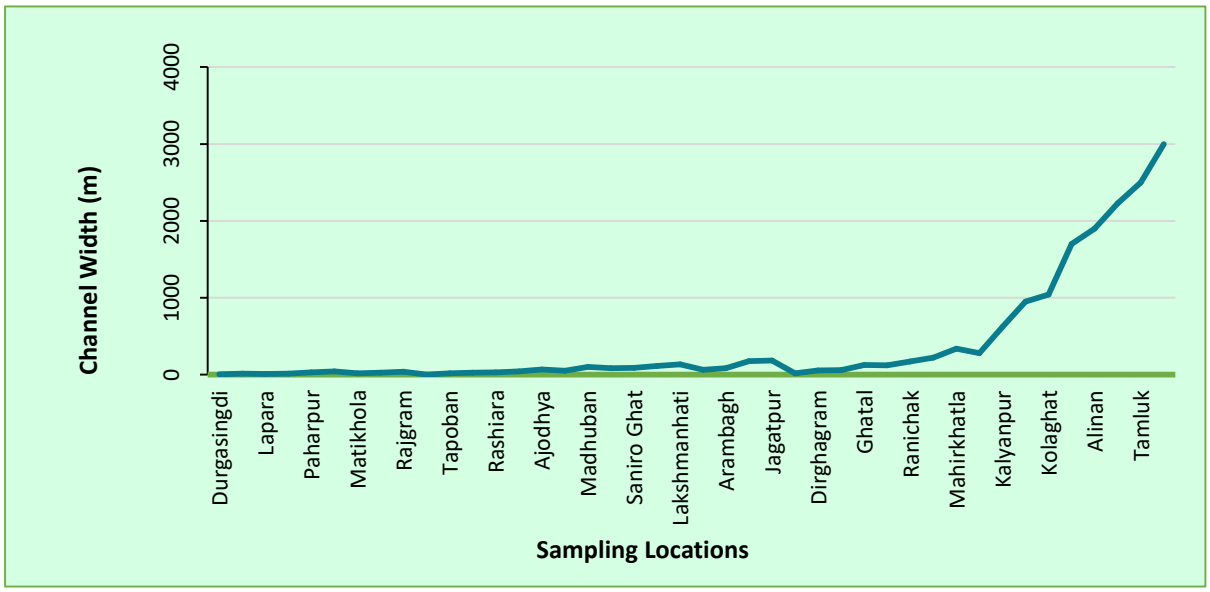


Figure 12 Channel width profile of the Rupnarayan River sampled during post monsoon season, 2020

Table 8 Depth class of Rupnarayan River sampled during post monsoon, 2020

Depth Class (m)	No. of Segments	% of Stretch
< 1	16	28.57
1 – 3	20	35.71
3 – 5	04	7.14
5 - 7	2	3.57

2.5 River Stretch with High Biodiversity Value

The survey found high abundance of Gangetic river dolphins in a 38 km long stretch between **Bandar to Kolaghat.** A total of 46 individuals in 22 occasions were recorded with an encounter rate of 1.2/km. Group sizes of 3 or more individuals were recorded on 8 occasions. During survey the water depth was recorded as 3.4 ± 1.25 m, indicating suitable depths for Gangetic dolphins. Winter migratory waterbirds Gadwall, Ruddy Shelduck and Common Redshank also recorded in this stretch.

3 THREATS TO THE BIODIVERSITY OF THE RUPNARAYAN RIVER

The tract of the Rupnarayan River from rolling upland to coastal estuary possesses varied gradient of habitats and life forms and has shaped the local economy of agrarian community along the river. The differential resource use by different stakeholders has resulted in varied impacts and threats along the length of the River.

3.1 Upper Zone

- The upper zone was once heavily forested is now denuded with increase in human population and expansion of agriculture (Nandy & Pal, 2014). Reduction in river discharge due to combined effect of climate change and water withdrawal is likely to have severe impact on human health and agricultural systems of the upper zone (Mahapatra et al., 2014). Water quality parameters assessed by CPCB at one

location near Bankura town in 2016 revealed that the dissolved oxygen (DO) ranged from 6 mg/L to 9.5 mg/L and the pH ranged from 7.2 to 8.3 (CPCB, 2016).

- During the post-monsoon season water quality assessment of pH was in the range of 8.93 to 0.01 (Figure 14) and Dissolved Oxygen (DO) between 1.55mg/l to 3.35mg/l (Figure 13).

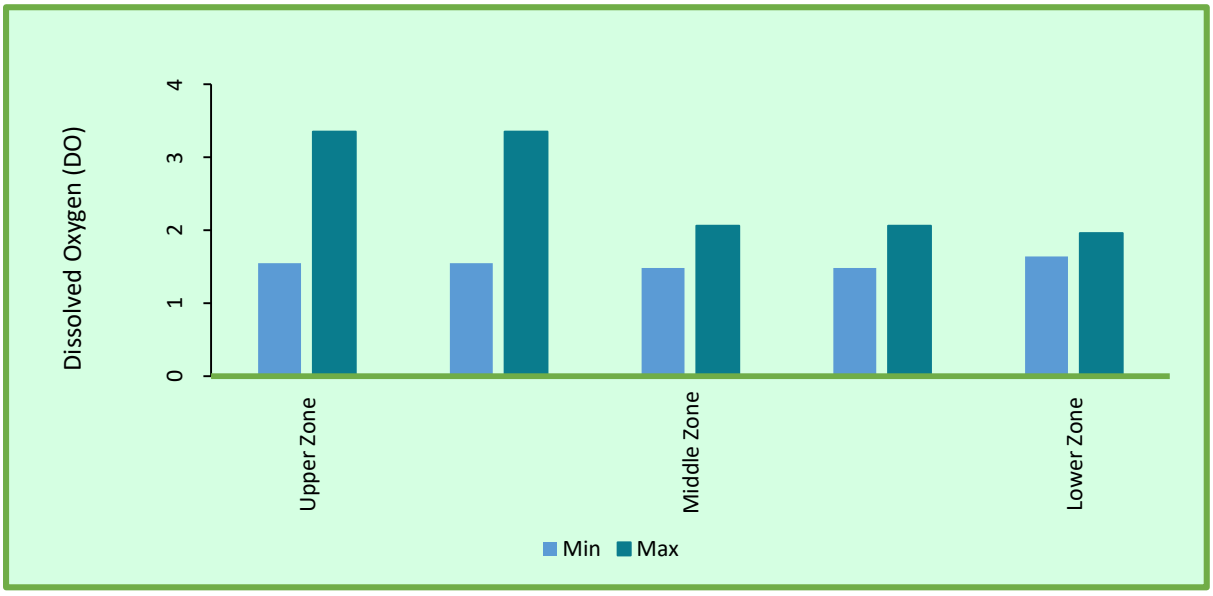


Figure 13 Dissolved Oxygen level observed during post monsoon survey in the Rupnarayan River

3.2 Middle Zone

- Diversion and water abstraction for irrigation, urban and industrial consumption and heavy sand mining pressure has led to severe changes in the channel bed structure, alteration of the flow regime and ground water depletion of the middle zone (Santra et al., 2016). Assessment of water quality parameters in recent past by CPCB at Dwarakeshwar and Shilabati confluence near Ghatal revealed that the dissolved oxygen (DO) ranged from 4.7 mg/L to 8.3 mg/L and the pH ranged from 6.9 to 8.1 (CPCB, 2016).

- During the post-monsoon season water quality assessment pH ranged between 9.24 to 9.65 (Figure 14) and Dissolved Oxygen (DO) between1.48mg/l to 2.06mg/l (Figure 13).

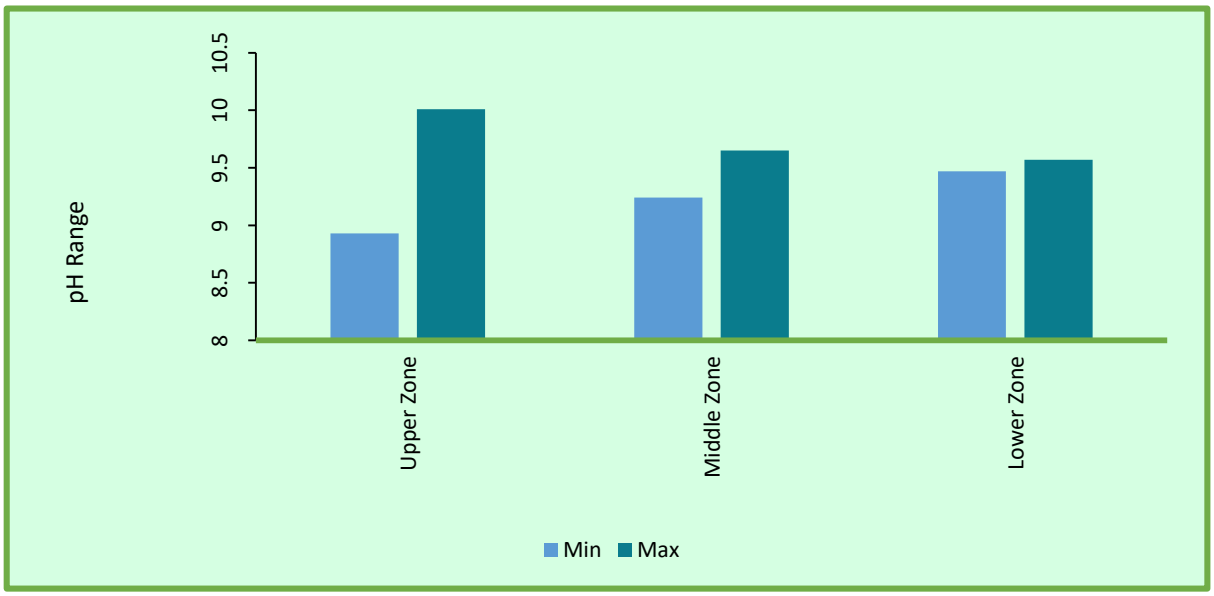


Figure 14 pH level observed during post monsoon survey in the Rupnarayan River.

3.3 Lower Zone

- Water quality parameters assessment performed by CPCB at two locations (Kolaghat and Geonkhali) revealed that the dissolved oxygen (DO) ranged from 4.8 mg/L to 9.5 mg/L and the pH ranged from 7.2 to 8.5 (CPCB,2016).

- During the post monsoon season water quality assessment pH ranged between 9.47 to 9.57 (Figure 14), Dissolved Oxygen (DO) 1.64mg/l to 1.96mg/l for (Figure 13)

- The lower stretch of the river is under heavy anthropogenic pressure, major towns like Tamluk, Nurpur, Kolaghat etc. fall in this stretch. Ferry is a major form of transport for majority of the people Due to the tidal influence in this stretch, the increased river width and depth facilitates upstream movement of larger cargo vessels which adds to river traffic (Figure 15).

- Having major cities alongside the river leads to heavy fishing and sand mining activities in the area to meet the demands of the city dwellers.

Table 9 Occurrence of various predictors of anthropogenic influence in the Rupnarayan River

Anthropogenic factors	Occurrence of Anthropogenic Influences in Rupnarayan River		
	Upper	Middle	Lower
Ferry Intensity	0.00	14.29	26.19
Fishing Intensity	4.76	23.81	33.33
Riverbed Agriculture	14.29	21.43	14.29
Sand Mining	16.67	14.29	23.81
Water Extraction	28.57	23.81	33.33
Built Up	16.67	14.29	23.81
Brick Kiln	21.43	9.52	19.05
Stray Dogs	26.19	28.57	23.81
Livestock	28.57	26.19	21.43
Religious Activities	2.38	2.38	23.81

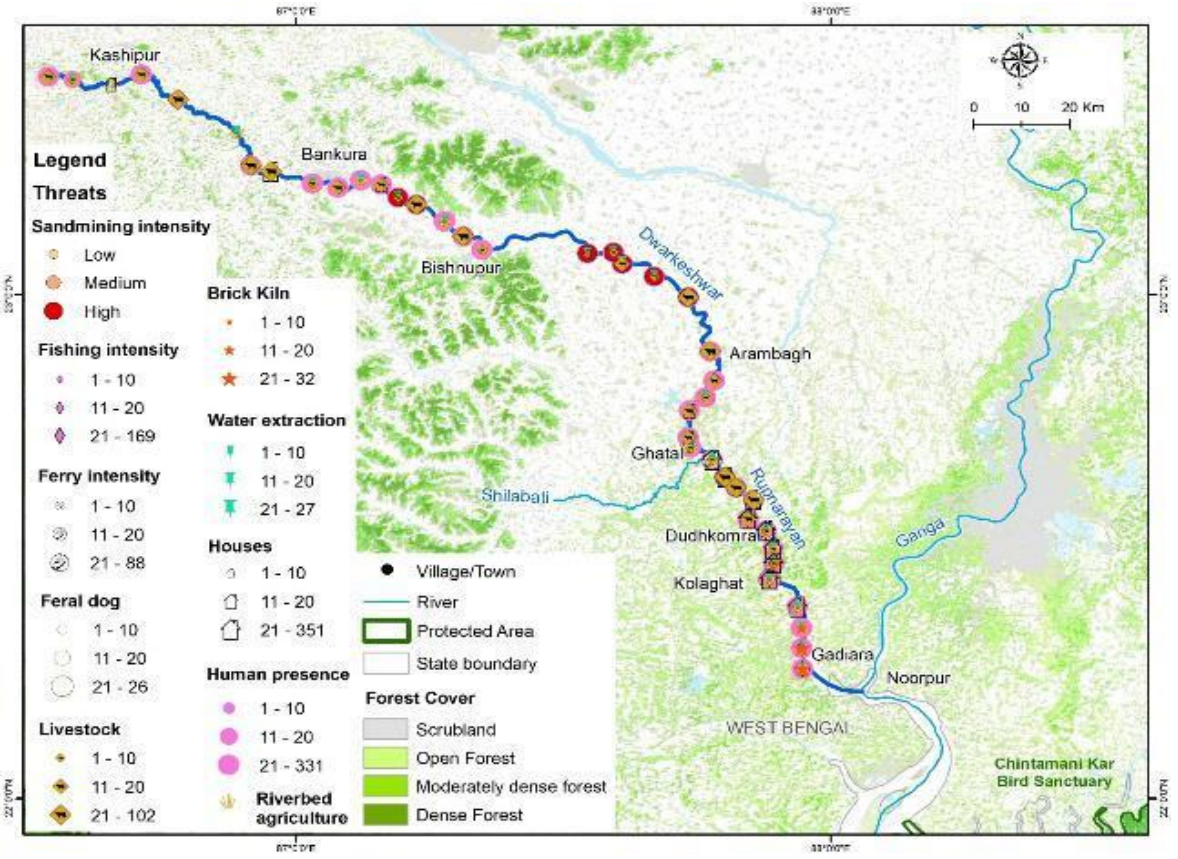


Figure 15 Threats observed during post monsoon survey in the Rupnarayan River

4 CONCLUSIONS

Dense human population, expanding agriculture and uncontrolled consumption of groundwater are the probable reason for altered flow regime in the upper and middle zones of the Rupnarayan River. The results of water quality parameters, as assessed by CPCB suggests that the river is less affected by wastewater disposal issue, but with expanding human population and the transformation of riverscapes into other land uses there is need to monitor these values for conservation planning.

5 CONSERVATION IMPLICATIONS

The upper and middle zones of the Rupnarayan River are facing unprecedented alteration in the flow regime due to intensive agricultural practices and water abstraction for domestic use, However, the lower zone of the Rupnarayan River after joining with Shilabati River enhances sub surface flow but water chemistry is highly modified due to the changes in salinity regimes caused by tidal fluctuation in the estuarine areas. The effects of fishery related mortality of the Gangetic dolphins due to entanglement in fishing nets, incidental hit by propellers of the vessels and boats considered to be one of the major driving factor in population decline, there is general gap of information regarding impact of vessel traffic on Gangetic dolphins. Rescue and rehabilitation protocols for Gangetic dolphins are required to effectively dealing with net entanglement or injury due to vessel collision. Appropriate training of frontline staff and extensive outreach among all stakeholders are also necessary for mitigation.

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ANNEXURE I

List of water and water associated bird species

Order	Family	Species Name	Scientific Name	IUCN Status	Residential status	Feeding Guilds	Reconnaissa-nce survey	Post-monsoon 2020
Accipitriformes	Pandionidae	Osprey	*Pandion haliaetus*	LC	R/WM	P	-	+
Anseriformes	Anatidae	Northern Pintail	*Anas acuta*	LC	WM	H/C	+	-
		Gadwall	*Mareca strepera*	LC	WM	H	+	+
		Ruddy Shelduck	*Tadorna ferruginea*	LC	WM	O	-	+
Charadriifomes	Charadriidae	Kentish Plover	*Charadrius alexzandrinus*	LC	R/LM	C	-	+
		Little ringed Plover	*Charadrius dubius*	LC	R	C	-	+
		Red-wattled Lapwing	*Vanellus indicus*	LC	R	C	+	+
	Jacanidae	Bronzed Winged Jacana	*Metopidius indicus*	LC	R	H/I	-	+
		Pheasent Tailed Jacana	*Hydrophasianus chirurgus*	LC	R/LM/SM	H/I	-	+
	Laridae	Brown-headed Gull	*Larus brunnicephalus*	LC	R/WM	C	+	-
		Pallas's Gull	*Larus ichthyaetus*	LC	WM	C	+	-
	Scolopacidae	Common Greenshank	*Tringa nebularia*	LC	WM	C	-	+
		Common Redshank	*Tringa totanus*	LC	WM	C	-	+
		Common Sandpiper	*Actitis hypoleucos*	LC	R/WM	I	+	+
		Temminck's Stint	*Calidris temminckii*	LC	WM	C	-	+
Ciconiiformes	Ciconiidae	Asian Openbill	*Anastomus oscitans*	LC	R	C	-	+
Coraciiformes	Alcedinidae	Common Kingfisher	*Alcedo atthis*	LC	R/SM/WM	P/I	+	+
		Pied Kingfisher	*Ceryle rudis*	LC	R	P/I	-	+
		White-throated Kingfisher	*Halcyon gularis*	LC	R	P/C	+	+

Gruiformes	Rallidae	White-breasted Waterhen	*Amaurornis phoenicurus*	LC	R	O	-	+
Passeriformes	Motacillidae	Citrine Wagtail	*Motacilla citrola*	LC	R	I	-	+
		Grey Wagtail	*Motacilla cinerea*	LC	R	I	-	+
		White Wagtail	*Motacilla alba*	LC	R	I	+	+
Pelecaniformes	Ardeidae	Black Crowned Night Heron	*Nycticorax nycticorax*	LC	R/LM	C	-	+
		Cattle Egret	*Bubulcus ibis*	LC	R	C/I	+	+
		Grey Heron	*Ardea cinerea*	LC	R	P/I	-	+
		Indian Pond Heron	*Ardeola grayii*	LC	R/LM	P/I	+	+
		Little Egret	*Egretta garzetta*	LC	R/LM	P/I	+	+
		Purple Heron	*Ardea purpurea*	LC	R/LM	P/I	-	+
Podicipediformes	Podicipedidae	Little Grebe	*Tachybaptus rufficolis*	LC	R	P/C	-	+
Suliformes	Phalacrocoracidae	Little Cormorant	*Microcarbo niger*	LC	R	P/C	-	+

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Abbreviation LC-Least Concerned,

R- Resident, WM-Winter migratory, R/WM-Resident and winter migrant, R/LM-Resident with local migrant, R/SM/WM-Resident with summer and winter movements, R/LM/SM- Resident local as well as summer movements

C-Carnivore, H-herbivore, O-Omnivore, P-Piscivore, I-Insectivore, H/C-Herbivore/Carnivore, H/I-Herbivore/Insectivore, P/I-Piscivore/Insectivore, C/I- Carnivore/Insectivore, P/C-Piscivore/Carnivore

Annexure II

List of fishes found in the Rupnarayan River basin

Species name	Common name	IUCN Status
Anguilla bengalensis	Indian mottled eel	NT
Tenualosa ilisha	Hilsa/Hilsa shad	LC
Setipinna taty	Scaly hairfin anchovy	LC
Chitala chitala	Indian featherback/knifefish	NT
Setipinna phasa	Gangetic hairfin anchovy	LC
Coilia ramcarati	Ramcarat grenadier anchovy	DD
Pethia ticto	Ticto barb	LC
Chagunius chagunio	*Chaguni*	LC
Mystus cavasius	Gangetic Mystus	LC
Wallago attu	Wallago/Boal	NT
Xenetodon cancila	Freshwater garfish	LC
Polynemus paradiseus	Paradise threadfin	LC
Eleutheronema tetradactylum	Fourfinger threadfin	DD
Pseudapocryptes elongatus	Pseudapocryptes elongatus	LC
Parapocryptes serperaster	Goby	LC
Scartelaos cantoris		DD
Anabas testudineus	Climbing perch	LC
Terapon jarbua	Jarbua terapon	LC
Eleotris fusca	Dusky sleeper	LC
Odontamblyopus rubicundus	Red eelgoby	LC
Otolithoides pama	Pama croaker	DD
Otolithoides biauritus	Bronze croaker	DD
Macrognathus pancalus	Barred spiny eel	LC
Cynoglossus lingua	Long tongue sole	LC
Cynoglossus punticeps	Speckled tonguesole	DD
Amblypharyngodon microlepis	Indian carplet	LC
Parambassis lala	Highfin glassy perchlet	NT
Macrognathus aculeatus	Lesser spiny eel	DD
Sperata seenghala	Giant river-catfish	LC
Mastacembelus armatus	Spiny eel	LC
Salmostoma bacaila	Large razorbelly minnow	LC
Labeo bata	Bata	LC
Glossogobius giuris	Gangetic tank goby	LC
Lates calcarifer	Barramundi	DD
Channa gachua	Dwarf snakehead	LC
Chitala chitala	Feather back	NT
Gudusia chapra	Indian river shad	LC
Monopterus cuchia	Gangetic mudeel	LC
Channa punctata	Spotted snakehead	LC

Harpadon nehereus	Bombay duck	NT
Amblypharyngodon mola	Mola carplet	LC
Pagasius pangasius	Pungas	LC
Chelon parsia	Goldspot mullet	DD
Channa marulius	Giant snakehead	LC
Mystus gulio	Long-whiskered catfish	LC
Rhinomugil corsula	Corsula	LC

Annexure III

List of Vegetation species in the Rupnarayan River basin

Family	Botanical Name	Habit	Habitat	IUCN status
Amaranthaceae	*Alternanthera philoxeroides* (Mart.) Griseb.	Herb	Marshy	–
	Alternanthera sessilis (L.) R.Br. ex DC.	Herb	Marshy	LC
	Alternanthera ficoidea (L.) P.Beauv.	Herb	Marshy	–
Asteraceae	*Grangea maderaspatana* (L.) Poir.	Herb	Marshy	LC
	Xanthium strumarium L.	Herb	Riparian	–
	Mikania scandens (L.) Willd.	Climber	Riparian	–
	Parthenium hysterophorus L.	Herb	Riparian	–
	Tridax procumbens L.	Herb	Riparian	–
	Cyanthillium cinereum (L.) H.Rob.	Herb	Marshy	–
Boraginaceae	*Heliotropium curassavicum* L.	Herb	Marshy	LC
	Heliotropium supinum L.	Herb	Marshy	–
Commelinaceae	*Commelina benghalensis* L.	Herb	Marshy	LC
Convolvulaceae	*Ipomoea aquatica* Forssk.	Herb	Aquatic	LC
	Ipomoea carnea Jacq.	Herb	Riparian	–
	Merremia emarginata (Burm.f.) Hallier f.	Herb	Marshy	LC
	Evolvulus nummularius (L.) L.	Herb	Marshy	–
Cyperaceae	*Cyperus rotundus* L.	Sedge	Aquatic	–
Euphorbiaceae	*Euphorbia hirta* L.	Herb	Marshy	–
	Jatropha curcas L.	Shrub	Riparian	LC
	Jatropha gossypiifolia L.	Shrub	Riparian	LC
Linderniaceae	*Torenia crustacea* (L.) Cham. & Schltdl.	Herb	Marshy	LC
Marsileaceae	*Marsilea mutica* Mett.	Herb	Aquatic	–
Molluginaceae	*Glinus oppositifolius* (L.) Aug.DC.	Herb	Marshy	LC
Onagraceae	*Ludwigia perennis* L.	Herb	Marshy	LC
	Ludwigia adscendens (L.) H.Hara	Herb	Aquatic	–
Polygonaceae	*Persicaria hydropiper* (L.) Delarbre	Herb	Aquatic	LC
Portulacaceae	*Portulaca oleracea* L.	Herb	Marshy	LC
Rubiaceae	*Dentella repens* (L.) J.R.Forst. & G.Forst.	Herb	Marshy	LC

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